INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN 2278 – 0211 (Online)

Intilligent Inverter Using Aurdino for Solar Power Applications

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Abstract:
Inverters of a Photovoltaic based system always demand huge capacitor at the output for producing the pure Sine wave which is often costly and occupies more space. In this paper a novel Inverter purely made of power electronic devices and controlled by using Aurdino micro controller is proposed which had eliminated the need of huge capacitors at the output with no compromise in efficiency. An attempt has also been made to automate the cooling system and conserve the energy. Simulations were done in Proteus ISIS software and tested practically in the Laboratory.

Keywords*: Aurdino, Proteus ISIS simulation, Renewable Energy, Bridge Inverter*

1. Introduction

Growing demand for electric energy highlights the significance of renewable energy utilization. Among various renewable sources, solar power happens to be the fore most because of its availability, abundance and pollution free nature focusing on solar power utilization, however, demands on developing a high efficient low cost converter.

Renewable energy is the best solution to overcome these problems. Currently, the fastest growing renewable energy source is the solar energy all over the world, because, it is the easiest and inexpensive way to generate and preserve the energy from the sunlight. Therefore, a device with its system needs to convert this sunlight to a useable energy [1]-[3]. A high efficiency solar panel is a device that converts photons of light from the sun into electricity. The produced electricity is of DC in nature but the home appliances are of AC so an Inverter is turned as an essential part of requirement.

A DC to AC inverter changes 12 or 24 volts DC to 120 or 240 VAC. This is a version of this using the Aurdino micro-controller. We have two variations as presented below and will use the exact same micro- Controller program not only to drive the power conversion process but to monitor other functions as well. Other features include:

- Monitor battery and input power condition and shutdown if battery voltage is too low. (Less than 11 volts.)
- Monitor the transistor heat sink assembly and turn on a cooling fan if too hot, which in turn conserve the energy.
- Power up slowly to prevent huge current surges on the 12/24 volts source.
- Temperature, humidity measurement control quite simple
- Relatively inexpensive and easy to build.

1.1. Block Diagram

The general block diagram showing the function of the proposed project was shown in Figure 1. The controlled Inverter was connected directly to the Solar Panels, which takes the DC voltage and converts it into the optimised AC voltage at which the load operates with maximum efficiency. The Inverter was controlled by a controller which was usually a microcontroller programmed as per requirement

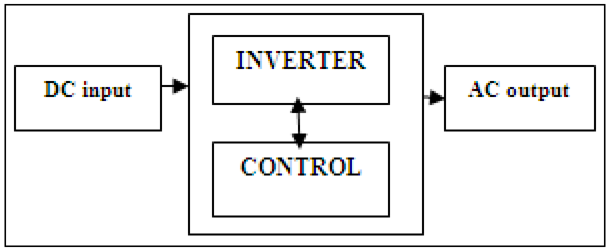

Figure 1: Block Diagram of the Proposed Project

2. Intelligent Inverter

2.1. Aurdino

For production of Sinusoidal Pulse Width Modulated Signal (SPWM), a code was written in separate software and dumped into the microcontroller. The circuit was simulated and the output was checked with the help of Oscilloscope available in the component library. The output was shown in the Figure 2.

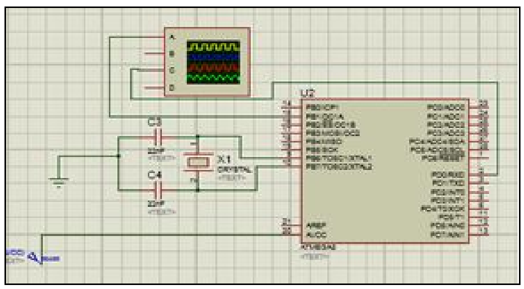

Figure 2: Schematic of the Aurdino *micro-controller in Proteus ISIS*

The ATmega8 is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega8 achieves throughputs approaching 1MIPS per MHz, allowing the system designed to optimize power consumption versus processing speed [4], [5]. The Aurdino board is shown in figure 3.

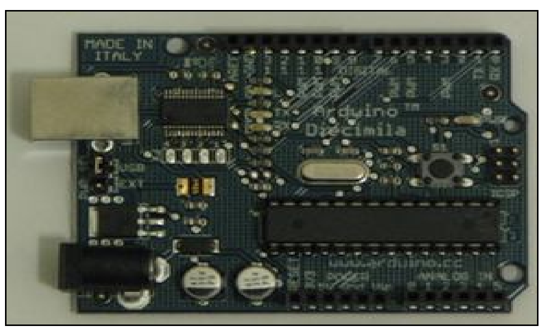

Figure 3: Schematic of the Aurdino *micro-controller board*

Aurdino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board [6].

2.2. Aurdino with two Half Bridge Drivers

The 4N37 opto-isolators serve to isolate the micro-controller from the higher voltages and electrical noise of the output circuits [7], [8]. The MOSFETs can be simply paralleled source to source, drain to drain, and gate to gate for higher currents and power output, as shown in figure 4. The 15k resistors are used to bleed the charges off the MOSFETs gates to turn the device off [9].

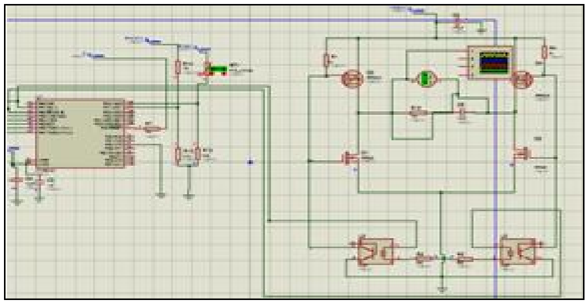

Figure 4: Schematic of the Aurdino *with full bridge*

In the figure 4, the H-bridge circuit is used to drive a transformer. The main advantage of this circuit is usage a non-center-tapped transformer. The MOSFETs were wired in parallel for greater power [10].
A common use of the H-bridge is an inverter, sometimes known as a single-phase bridge inverter. The H-bridge with a dc supply will generate a square wave voltage waveform across the load. For a purely inductive load, the current waveform would be a triangle wave with its depending on the inductance, switching frequency and input voltage [11].

2.3. Automatic Cooling System

The proposed project has the added feature of automatic cooing unit. The system turns on when the temperature at the work piece is increased above the reference temperature; the automatic coolant unit will active and automatically coolant fan on reduced the temperature [12]-[15]. Similarly when temperature decreases below the reference value the control unit deactivates. The fan by using Aurdino the process will continue according to the increase and decrease of the temperature, as shown in figure 5.

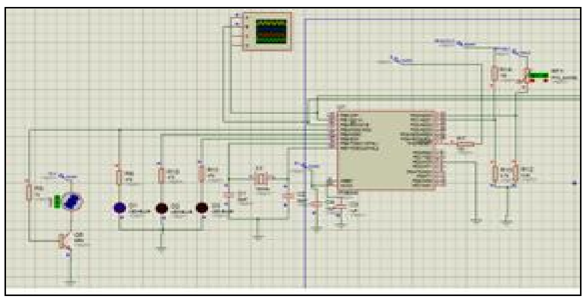

Figure 5: Screen shot of the automatic cooling system

The Aurdino is preprogrammed to take the temperature reading at its digital input pins after analyzing these inputs the Aurdino checks with commands in its program and reaches on conclusion, whether fan will be on/off. The Aurdino has a regulated power source quite good. The A/D is referenced from its required voltage (5V), so its produces accurate results.

3. Software Flowchart

The flow used for producing the Sinusoidal Pulse width Modulation signal using the Aurdino using ‘C’ language was shown in Figure 6.

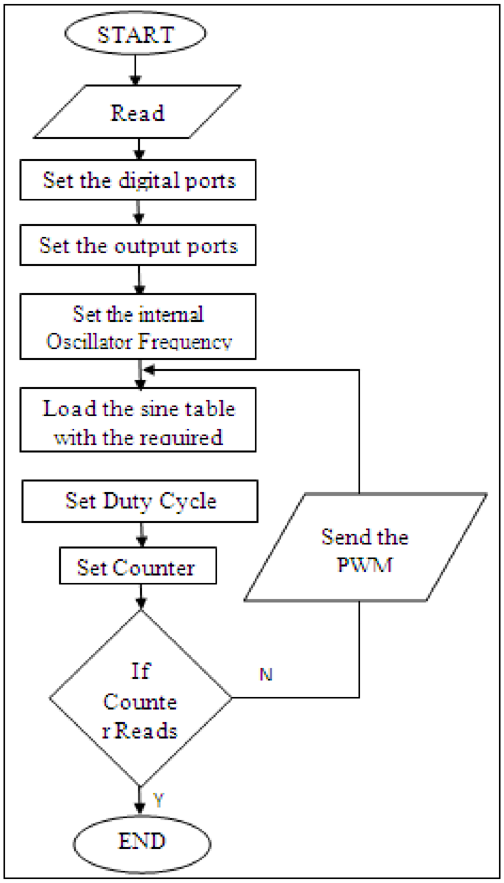

Figure 6: Flow Chart for producing the SPWM using the Aurdino

4. Simulation Results

4.1. PWM using Aurdino

Figure 7 shows the schematic of Aurdino microcontroller producing the SPWM signals. In programming, the main aspect was the switching signal time period, which should be 20ms (T= 1/f = 1⁄50HZ), as the frequency of the generated signal was 50Hz. But initially, the generated signal has a time period of 10ms (f=1/T=100Hz), which was very inappropriate. So, in order to achieve the required time period, the pulse count in the program was increased. Thereby, the SPWM signal with a 20msec time period was achieved.

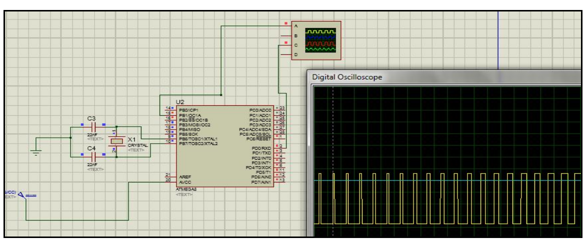

Figure 7: Schematic of the SPWM signal produced by Aurdino

4.2. Simulation Output

The schematic with Aurdino, full bridge diode rectifier IC and the controlled Inverter formed by MOSFETs was simulated and the output waveform was shown in the Figure 8. In this project the input voltage was $12V_{DC}$, and the output generated voltage was almost pure sinusoidal (9 V_{AC}) which was achieved with the RLC filter connected at the output terminals.

The efficiency $\eta = (V_{AC}/ V_{DC}) \times 100$

$= (9.4/12) \times 100$

$= 78.33$

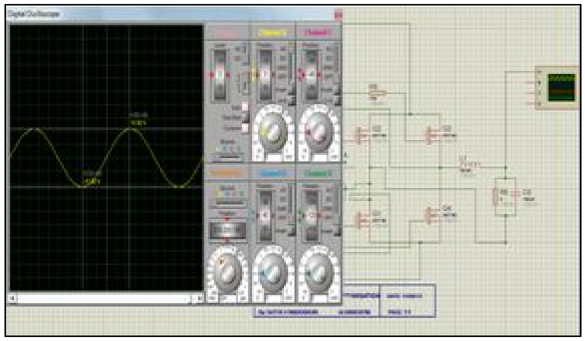

Figure 8: Simulated Output waveform of the proposed project

5. Practical Results

The DC signal was fed through the Inverter Bridge formed by the four MOSFETs, which were triggered by the SPWM signal produced by Aurdino. The output was a fluctuated sine wave which was then filtered using the RLC filter. The output waveform from the RLC filter was shown in Figure 9.

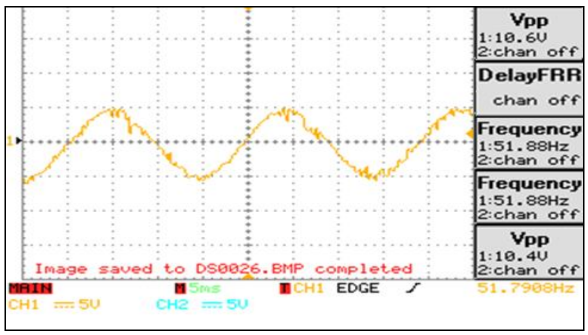

Figure 9: Practical output waveform of the proposed project

6. Discussion of Results

This chapter gives a clear overview of the results that were obtained at different stages of testing the system.

- The optimised output voltage was effectively produced from the designed system but the waveform was not a pure sine wave due to the presence of more noise. The frequency of the produced signal was quite good, which was within the allowed limits.
- It was also observed, the sudden drop in signal amplitude of the output voltage waveform, when travelling from positive peak to the negative peak. This was due to the improper switching of the MOSFETs.
- The reason for the improper switching of MOSFETs was the sinusoidal pulse width modulation signal generated by the Aurdino microcontroller was having more fluctuations, which were due to presence of more noise in the tracks.
- The noise can be eliminated by making a bigger board and placing more space between the components'.

7. Conclusion

In this paper a novel inverter was proposed and tested. From the results obtained from different tests performed, the designed system was able to produce the sine AC waveform from the supplied DC without the need of huge capacitors, which intern reduced the size and cost of the system. The control system made of Aurdino was efficient enough to generate the SPWM signals and programming was user friendly. The frequency of the produced waveform was within the allowed limits. The simplicity, small size, easy programming, less maintenance and low cost will definitely attracts the customers.

8. Future Scope

The use PIC microcontroller with more internal memory can also improve the quality of the Sinusoidal Pulse Width Modulation (SPWM) signals and there by the output can be pure Sine wave with improved efficiency.

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